GeroScience
https://doi.org/10.1007/s11357-026-02134-w

REVIEW

Frailty assessment tools in the emergency department and their predictive value for clinical outcomes: review of the literature

Dana Shiffer · Francesco Reggiani · Antonio Voza

Received: 10 August 2025 / Accepted: 26 January 2026
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Abstract Frailty is increasingly recognized as been associated with adverse outcomes in older adults presenting to the emergency department (ED). Timely identification of frailty can inform clinical decision-making, guide resource allocation, and improve patient-centered care. This review summarizes findings from 33 studies published between 2019 and 2025, evaluating the diagnostic performance and predictive value of frailty screening tools in the ED. Tools assessed include the Clinical Frailty Scale (CFS), Identification of Seniors at Risk, PRISMA-7, interRAI ED Screener, electronic Frailty Index, and several hybrid or lab-based instruments. Most tools demonstrated moderate to high sensitivity but limited specificity and poor-to-fair overall accuracy in predicting outcomes such as hospitalization, ICU admission, length of stay, readmission, functional decline, and mortality. While the CFS remains the most widely used due to its simplicity and clinical familiarity, newer tools show promise in improving predictive accuracy through automation or integration with triage scores. However, no single instrument emerged as ideal. Feasibility, standardization, and implementation challenges, particularly in high-acuity ED environments, persist across all tools. This review highlights the need for ED-specific frailty strategies that balance rapid screening with comprehensive assessment.

Keywords Frailty screening tools · Risk stratification · Geriatric population · Frailty in emergency department

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11357-026-02134-w.

D. Shiffer (✉) · A. Voza
Department of Emergency Medicine, IRCCS Humanitas Research Hospital, Rozzano, Milan, Italy
e-mail: dana.shiffer@humanitas.it

D. Shiffer · *Present Address:*
F. Reggiani · A. Voza
Department of Biomedical Sciences, Humanitas University, Pieve Emanuele, Milan, Italy

F. Reggiani
Nephrological Unit, Nephrology and Dialysis Division, IRCCS Humanitas Research Hospital, Rozzano, Milan, Italy

Introduction

The proportion of older people is steadily increasing, leading to a higher number of complex presentations to emergency departments (EDs) worldwide [1]. Frailty, a state of decreased physiological reserve and increased vulnerability to adverse health outcomes, is becoming increasingly common in this setting [2]. A systematic review reported that among community-dwelling adults aged ≥ 50 across 62 countries the prevalence of frailty varied between 12 to 24% [3]. In the ED, up

Published online: 19 February 2026

to 60% of older patients are considered frail [1]. These individuals face significantly higher risks of poor outcomes, including increased mortality, increased hospital admission and (LOS), functional and cognitive decline, and increased rates of readmission after discharge [4–6]. Thus screening for frailty is crucial for directing patients to appropriate care pathways and promotes awareness among ED healthcare worker of the complexity of older patients, while facilitating more efficient use of limited ED time and resources [1, 7].

In response to this need, various frailty screening tools have been developed to help clinicians assess older patients' vulnerability to adverse outcomes. Among these, the Clinical Frailty Scale (CFS) is one of the most widely and commonly used instruments in emergency and acute care settings due to its simplicity, visual format, and ease of application in fast-paced environments [8–10]. However, while the CFS is practical and well-established, it relies heavily on clinical judgment and may be influenced by variability in experience and interpretation [11]. Moreover, it may not fully capture the multidimensional nature of frailty, particularly with respect to cognition, social support, or pharmacological factors, which limits its ability to identify high-risk individuals with complex needs [11]. As a result, there is growing interest in alternative or complementary screening tools that incorporate broader biopsychosocial domains and offer improved diagnostic accuracy and objectivity in identifying frailty. Indeed over eighty-nine different measures have been used to assess frailty in the acute care literature [12]. Some focus on clinical judgment, others on physical criteria, comorbidity burden or functional status. In an attempt to standardize ED frailty screening, a recent international consensus study recommended that, frailty screening tools should be brief (≤ 5 min), and should identified key domains including functional ability, mobility, cognition, polypharmacy, and social factors [1].

The aim of this review is to summarize recent evidence on frailty tools in the ED, focusing on their ability to predict outcomes such as mortality, intensive care unit (ICU) admission, hospitalization, LOS, ED- readmission, and functional decline. It aims to clarify the comparative effectiveness of these tools and explore their clinical utility in guiding care for older adults in emergency settings.

Methods

Data sources and search strategy

Our PICOT question was "in older adults presenting to the ED, how does the use of frailty assessment tools, compared to no formal frailty assessment or other screening methods, predict adverse clinical outcomes such as mortality, hospital or ICU admission, ED readmission, functional decline, and LOS?". Relevant articles published between January 2019 and December 2025 were identified through a comprehensive search in PubMed. Search terms included combinations of "frailty assessment tools," "frailty score," "geriatric assessment," "emergency department," and "frailty screening." Additionally, manual searches were conducted to ensure all relevant studies within the established timeframe were included.

Eligibility criteria, study selection and data extraction

Three independent reviewers selected original research articles based on titles, abstracts, and eligibility criteria. Inclusion criteria included focus on frailty screening tools, participants aged 60 years or older, and studies conducted in emergency ED settings. Studies were excluded if they focused on non-geriatric populations, settings other than the ED, or trauma patients. Data extraction was conducted by two reviewers for each thematic category, with a third reviewer addressing any discrepancies. Full texts were reviewed, abstracted, and then synthesized for inclusion in this manuscript. Data were extracted using a structured template and organized thematically around clinical outcomes such as mortality, hospitalization, ICU admission, readmission, functional decline, and LOS. Initially, a total of 135 articles were identified and after applying eligibility criteria, 32 were included in the final review (see Table 1). We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines where applicable to ensure transparency and reproducibility.

Risk of bias and quality appraisal

The methodological quality of the included studies was assessed using the Critical Appraisal Skills Programme (CASP) Cohort Study Checklist, which evaluates key domains including clarity of aims, recruitment methods, measurement validity, confounding control, outcome assessment, follow-up completeness, and applicability.

Table 1 Summary of studies on frailty screening tools used in the ED and their ability to predict outcomes

Author(s), publication year	Country	Cohort age	Tool(s)	Outcomes	Key findings
Clark et al. (2019) [14]	Australia	≥ 75 years	CFS	LOS, 28-day mortality	CFS independently predicted 28-day mortality and longer stays
Eckart et al. (2019) [34]	Switzerland	≥ 75 years	HFRS	LOS, functional decline, 30-day mortality	HFRS linked to worse outcomes
Lewis et al. (2019) [9]	Australia	> 65 years	FP, CFS, SUHB	Mortality, ED return, QoL	All tools predicted outcomes; CFS most practical
Kaeppeli et al. (2020) [13]	Switzerland	≥ 65 years	CFS	30-day mortality	Higher CFS scores independently predicted mortality
Schuijt et al. (2020) [23]	Netherlands	≥ 70 years	VMS	90-day mortality, falls	Limited PPV but strong NPV for ruling out risk
Mowbray et al. (2020) [30]	Canada	> 75 years	ED Frailty Index, CTAS	30-day ED return, LOS, future hospitalization	ED FI Predicted hospitalization, readmission, LOS
Liu et al. (2020) [35]	China	≥ 60 years	FSQ	LOS, functional decline	Correlated with LOS
Heeren et al. (2020) [44]	Belgium	≥ 70 years	ISAR, fTRST, interRAI ED	LOS, hospitalization, 30 and 90 days ED readmission	Poor overall accuracy in predicting adverse outcomes
Elliott et al. (2021) [15]	UK	≥ 65 years	CFS	Hospital admission, mortality up to 2-year, LOS	Elevated CFS scores associated with increased admission and long-term mortality
Serina et al. (2021) [28]	USA	≥ 65 years	CFS	Hospital admission	Higher CFS correlated with admission at ED visit and within 30 days
Van Dam et al. (2021) [43]	Netherlands	≥ 70 years	APOP, InterRAI, ISAR-HP, VMS	Functional decline, institutionalization, 3-month mortality after ED visit	Limited predictive accuracy
Nygaard et al. (2022) [20]	Denmark	≥ 65 years	CFS, FP	90-day mortality	CFS showed superior predictive accuracy
Alshibani et al. (2022) [40]	UK	≥ 75 years	HFRS, CFS	30-day mortality, LOS > 10 days, and 30-day readmission	Both effective; although low correlation
Van Dam et al. (2022) [4]	Netherlands	≥ 70 years	ISAR-HP vs judgement	Functional decline, mortality	Poor prognostic accuracy
Zulfiqar et al. (2023) [29]	France	≥ 65 years	mSEGA, CCI	12-month mortality, ED-readmission	mSEGA predicted ED readmission, CCI predicted mortality
Supatanakij et al. (2023) [46]	Thailand	≥ 65 years	S-TRIAGE	28-day mortality	Strong mortality predictor
Ng et al. (2023) [45]	Taiwan	≥ 65 years	TFAS (CFS + TTAS)	Mortality, ICU admission	Better predictor than TTAS alone; reduced under-triage
Kabell Nissen et al. (2023) [22]	Switzerland	≥ 65 years	FaP-ED (CFS + NEWS)	30-day mortality	Hybrid model showed improved mortality prediction over CFS alone
O'Caoimh et al. (2023) [33]	Ireland	≥ 70 years	RISC	LOS, 1-year institutionalization	Predicted adverse outcomes effectively
Javadzadeh et al. (2024) [16]	Sweden	≥ 70 years	CFS	Short-, mid-, long-term mortality	Frail patients had nearly double the risk of death. High CFS (8–9) predicted > 20 × higher long-term mortality risk
Chung et al. (2024) [26]	South Korea	> 65 years	CFS-KTAS	Hospital, ICU admission, 30-day mortality	CFS-KTAS improved predictions over KTAS alone
Johansson et al. (2024) [27]	Sweden	> 65 years	CFS	Hospital admission, ED readmissions	CFS 5–8 linked with higher admissions and readmission rates
Barton et al. (2024) [32]	Australia	≥ 75 years	CFS	ED returns after falls	Limited utility for representations after falls

Table 1 (continued)

Author(s), publication year	Country	Cohort age	Tool(s)	Outcomes	Key findings
Munir Ehrlington et al. (2024) [18]	Sweden	≥ 65 years	CFS	7, 30, 90-day mortality, LOS	CFS ≥ 5 strongly associated with increased mortality and longer stays
Nygaard et al. (2024) [19]	Denmark	≥ 65 years	CFS, Braden Scale	90-day mortality	Both scales predicted mortality with poor-to-moderate accuracy
Sert et al. (2024) [36]	Turkey	≥ 65 years	CFS	ICU mortality, LOS	Frailty linked with prolonged LOS and ICU mortality
Ellis et al. (2025) [21]	UK	> 70 years	CFS	Mortality, LOS, readmissions	CFS predicted outcomes; concerns over inter-rater variability
Nagae et al. (2025) [24]	Japan	≥ 65 years	FI-lab vs NEWS, JTAS, and mJTAS	In-hospital mortality, discharge	FI-lab comparable to NEWS and JTAS; FI-lab predicted discharge home
Çelik et al. (2025) [25]	Turkey	> 65 years	PRISMA-7	ICU admission, 28-day mortality	Outperformed qSOFA and ESI for ICU admission, qSOFA for mortality
Kayhan Kocak et al. (2025) [37]	Turkey	≥ 65 years	CFS, ISAR, TRST	LOS, disability	CFS best predicted disability
Zaboli et al. (2025) [41]	Italy	> 65 years for all tools except TFC (all ages)	TFC, CFS, PRISMA-7, ISAR	30- and 90-day mortality, hospitalization	TFC outperformed other tools
Shiffer et al. (2025) [6]	Italy	≥ 65 years	eFI	Mortality, hospitalization, ICU admission, 30-day ED-readmission	Strong predictor of all outcomes

CFS, clinical frailty scale; *PRISMA-7*, Program of Research to Integrate Services for the Maintenance of Autonomy-7 items; *ISAR*, Identification of Seniors At Risk; *ISAR-HP*, ISAR-Hospitalized patients; *TRST*, Triage Risk Screening Tool; *fTRST*, Flemish version of TRST; *TFC*, triage frailty and comorbidity; *FI-lab*, frailty index laboratory; *NEWS*, National Early Warning Score; *FaP-ED*, Frailty-adjusted Prognosis in ED; *VMS*, Dutch Safety Management Program; *JTAS*, Japan Triage and Acuity Scale; *mJTAS*, modified Japan Triage and Acuity Scale; *FP*, Fried's phenotype; *qSOFA*, quick Sequential Organ Failure Assessment; *ESI*, Emergency Severity Index; *KTAS*, Korean Triage and Acuity Scale; *mSEGA*, modified Short Emergency Geriatric Assessment; *CCI*, Charlson Comorbidity Index; *RISC*, Screening in the Community; *HFRS*, Hospital Frailty Risk Score; *FSQ*, Frailty Screening Questionnaire; *SUHB*, Stable, Unstable, Help to walk, Bedbound; *TFAS*, Triage Frailty Acuity Scale, *S-TRIAGE*, Screening Tool Risk Score Assessment in the Emergency Department for Geriatric; *interRAI ED*, International Resident Assessment Instrument in ED; *APOP1*, acutely presenting older patient; *eFI*, electronic Frailty Index. *CTAS*, Canadian Triage and Acuity Scale; *KTAS*, Taiwan Triage and Acuity Scale

Each study was rated as high, moderate, or low quality based on these domains, and an overall quality judgment was assigned according to the predominant domain ratings. Data from the quality assessment were summerized in a dedicated supplementary table (Supplementary Table S1). This approach ensured consistent appraisal of study rigor and internal validity across the different study designs.

Summary of included studies and comparative findings

A total of 32 studies met the inclusion criteria and were included in the final review. Their main characteristics, frailty tools, outcomes, and key findings are summarized in Table 1, organized by publication year and study design. In addition, Figs. 1 and 2 provide a graphical overview of the comparative predictive performance of the key frailty instruments across outcomes. Specifically, Fig. 1 depicts the discriminative accuracy (AUC values) of each tool for predicting mortality, hospitalization, readmission, and other composite endpoints, while Fig. 2 presents the corresponding odds ratios or hazard ratios for adverse outcomes associated with frailty. Together, these summaries highlight the moderate to high predictive capacity of most frailty tools, particularly the CFS, FaP-ED, and hybrid triage-based models such as TFAS and S-TRIAGE, in identifying older adults at risk of poor outcomes in emergency settings.

Frailty tools and mortality prediction

Mortality is a key focus in frailty research in emergency settings, where early identification of high-risk patients can significantly influence care planning and outcomes. Among the various tools developed, the CFS is one of the most extensively studied and widely implemented. Several studies have confirmed the ability of CFS to predict both short- and long-term mortality. Kaeppeli et al., [13] demonstrated that higher CFS scores were independently associated with increased 30-day mortality, regardless of age or presenting condition. Similarly, Clark et al. [14], and Elliott et al., [15] found stronger associations between elevated CFS scores and mortality even up to two years after ED presentation. Javadzadeh et al., [16] demonstrated that the CFS reliably predicted short-, mid-, and long-term mortality after ED admission, with the highest frailty category (CFS 8–9) predicting a more than 20-fold increase in long-term mortality risk compared to non-frail individuals (CFS 1–4). These findings have been reinforced in diverse populations, including studies from Taiwan [17], and Sweden [18] which consistently show that frail ED patients assessed with the CFS experienced higher mortality rates.

Other frailty tools have been compared to CSF in predicting mortality. Nygaard et al. [19] compared the CFS and Braden Scale (BS) and fond both associated with 90-day mortality however with poor-to-moderate prognostic accuracy. An earlier study by the same group [20] compared to efficacy of CFS and Fried's Phenotype (FP) in predicting 90-day mortality among elderly patients acutely admitted to EDs in Denmark. They concluded that while both were associated with 90-day mortality, the CFS demonstrated superior predictive accuracy.

Despite extensive validation, concerns regarding the reliability of CFS assessments in the ED setting persist. Factors such as time constraints, incomplete patient histories, and high patient turnover contribute to variability and potential inconsistencies in the application of the CFS, highlighting the need for standardized training and clear implementation protocols. A recent study by Ellis et al., [21] assessed the CFS on over123,000 ED visits in London, and found that higher CFS scores significantly predicted increased mortality, longer stays, and readmissions. However, they found that considerable scoring variability arose from inter-rater differences and acute illness severity and suggested exploring automated methods to improve scoring reliability. One promising solution is the Frailty-adjusted Prognosis in ED (FaP-ED) tool, introduced by Kabell Nissen et al., [22]. this hybrid model combines CFS with National Early Warning Score (NEWS) to improve mortality prediction. The FaP-ED tool showed stronger predictive performance for 30-day mortality than either tool alone, illustrating the advantage of combining acute illness severity and frailty indicators.

Other frailty screening tools have been assessed to predict mortality. The Dutch Safety Management Program (VMS) screener, evaluated by Schuijt et al. [23], demonstrated only limited predictive value. Although associated with 90-day mortality and falls, the VMS had a low positive predictive value but a high negative predictive value, suggesting it may be better suited for ruling out low-risk patients rather than identifying those at high risk.

To reduce variability and enhance objectivity, researchers have turned to automated, data-driven frailty tools**.** These include laboratory-based frailty indices derived from routinely collected clinical data. Nagae et al., [24] evaluated the Frailty Index–Laboratory (FI-lab), using 24 standard laboratory parameters from blood tests and found stronger associations with in-hospital mortality, NEWS and Japan Triage and Acuity Scale (JTAS). Interestingly, the FI-lab was distinctively associated with the likelihood of discharge to home, suggesting its potential utility in reflecting clinical severity of illness and recovery potential in the ED.

Overall, these findings demonstrate that frailty, whether assessed through clinical scales like the CFS, hybrid models like FaP-ED, or automated tools like FI-Lab, is a strong and independent predictor of mortality in the ED.

Frailty and ICU admission or hospitalization

Beyond mortality, frailty has emerged as a powerful predictor of other key outcomes, including hospital and ICU admissions. Identifying frailty early can help clinicians determine which patients may require higher levels of care, guide resource allocation, and potentially avoid unnecessary admissions.

Several studies have highlighted the predictive value of frailty tools in determining hospital or ICU

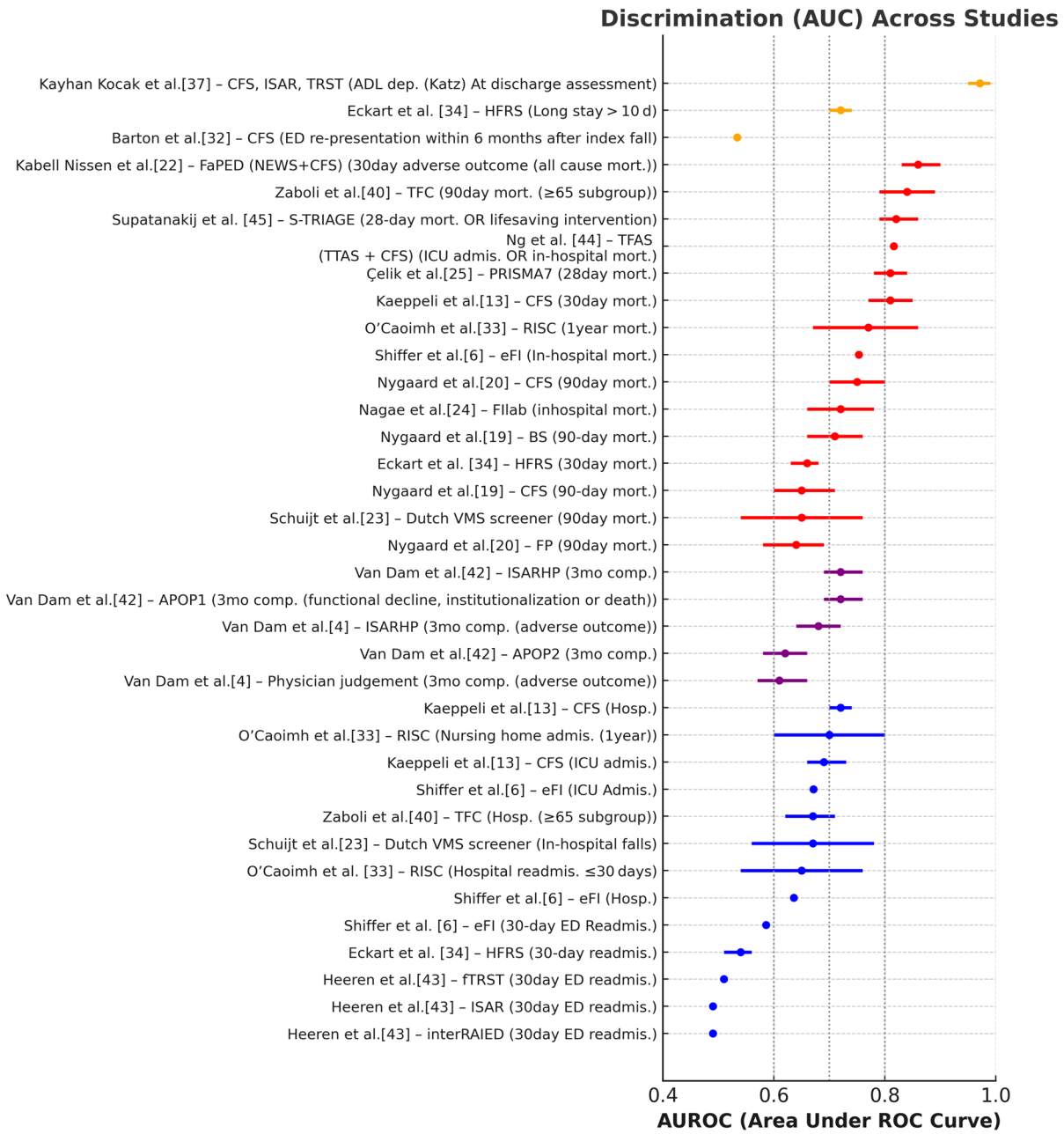
Discrimination (AUC) Across Studies
Kayhan Kocak et al.[37] – CFS, ISAR, TRST (ADL dep. (Katz) At discharge assessment)
Eckart et al. [34] – HFRS (Long stay > 10 d)
Barton et al.[32] – CFS (ED re-presentation within 6 months after index fall)
Kabell Nissen et al.[22] – FaPED (NEWS+CFS) (30day adverse outcome (all cause mort.))
Zaboli et al.[40] – TFC (90day mort. (≥65 subgroup))
Supatanakij et al. [45] – S-TRIAGE (28-day mort. OR lifesaving intervention)
Ng et al. [44] – TFAS
(TTAS + CFS) (ICU admis. OR in-hospital mort.)
Çelik et al.[25] – PRISMA7 (28day mort.)
Kaeppeli et al.[13] – CFS (30day mort.)
O'Caoimh et al.[33] – RISC (1year mort.)
Shiffer et al.[6] – eFI (In-hospital mort.)
Nygaard et al.[20] – CFS (90day mort.)
Nagae et al.[24] – FIlab (inhospital mort.)
Nygaard et al.[19] – BS (90-day mort.)
Eckart et al. [34] – HFRS (30day mort.)
Nygaard et al.[19] – CFS (90-day mort.)
Schuijt et al.[23] – Dutch VMS screener (90day mort.)
Nygaard et al.[20] – FP (90day mort.)
Van Dam et al.[42] – ISARHP (3mo comp.)
Van Dam et al.[42] – APOP1 (3mo comp. (functional decline, institutionalization or death))
Van Dam et al.[4] – ISARHP (3mo comp. (adverse outcome))
Van Dam et al.[42] – APOP2 (3mo comp.)
Van Dam et al.[4] – Physician judgement (3mo comp. (adverse outcome))
Kaeppeli et al.[13] – CFS (Hosp.)
O'Caoimh et al.[33] – RISC (Nursing home admis. (1year))
Kaeppeli et al.[13] – CFS (ICU admis.)
Shiffer et al.[6] – eFI (ICU Admis.)
Zaboli et al.[40] – TFC (Hosp. (≥65 subgroup))
Schuijt et al.[23] – Dutch VMS screener (In-hospital falls)
O'Caoimh et al. [33] – RISC (Hospital readmis. ≤30 days)
Shiffer et al.[6] – eFI (Hosp.)
Shiffer et al. [6] – eFI (30-day ED Readmis.)
Eckart et al. [34] – HFRS (30-day readmis.)
Heeren et al.[43] – fTRST (30day ED readmis.)
Heeren et al.[43] – ISAR (30day ED readmis.)
Heeren et al.[43] – interRAIED (30day ED readmis.)
0.4
0.6
0.8
1.0
AUROC (Area Under ROC Curve)

Fig. 1 Discrimination (AUC) across studies. Each point represents the reported area under the receiver operating characteristic (AUROC) curve for a frailty assessment tool predicting key outcomes in emergency department cohorts. Horizontal lines denote 95% confidence intervals where available. Colors correspond to outcome categories: red = mortality; blue = admission/hospitalization, readmission/return; purple = composite outcomes; and orange = other outcomes

admission risk. Çelik et al., [25] compared the performance of the 7 item questionnaire, Program of Research to Integrate Services for the Maintenance of Autonomy- 7 items (PRISMA-7), with the quick Sequential Organ Failure Assessment (qSOFA) and the Emergency Severity Index (ESI) in an ED setting. They found that PRISMA-7 outperformed both in predicting ICU admissions among older adults,

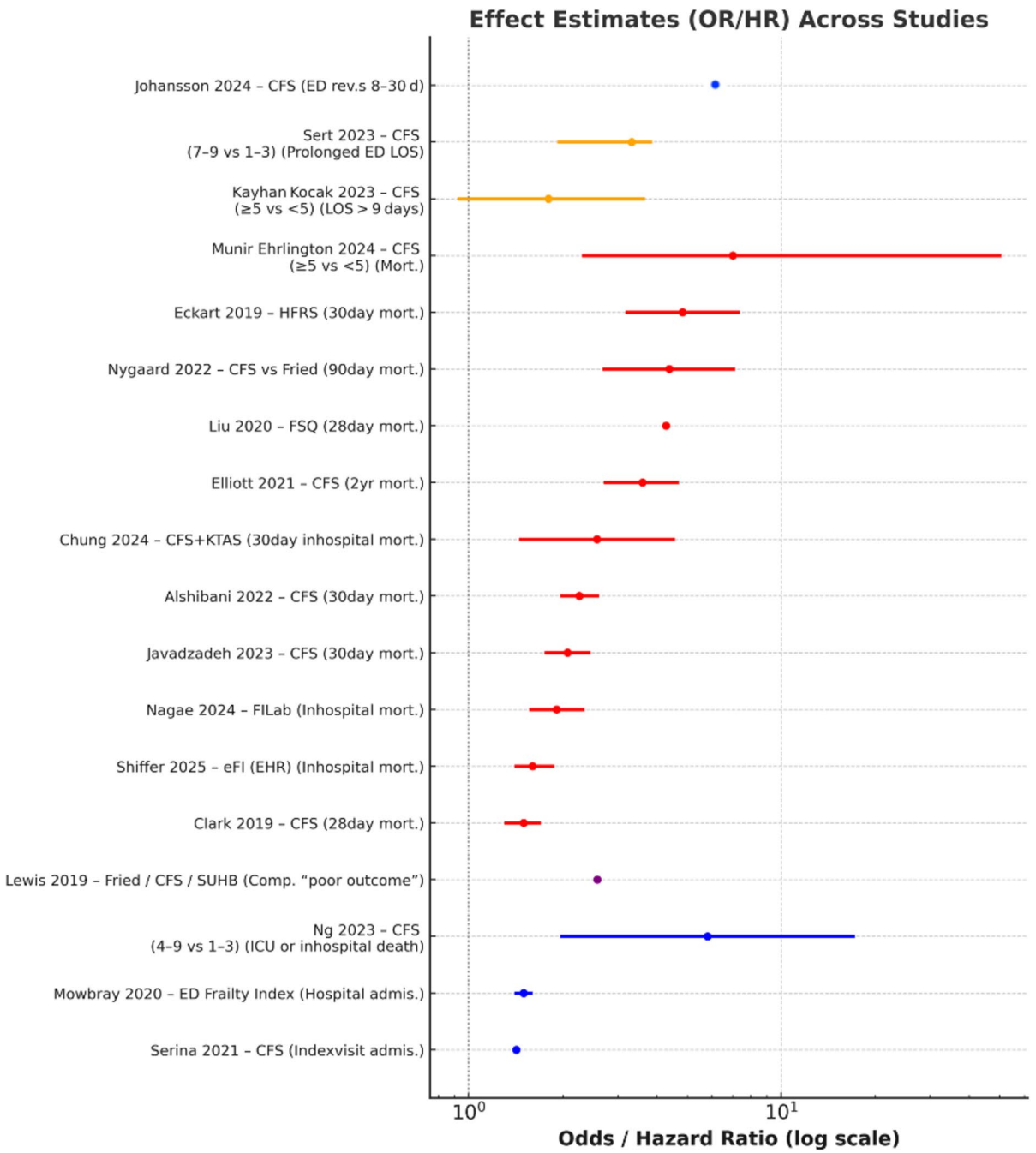
Effect Estimates (OR/HR) Across Studies
Johansson 2024 – CFS (ED rev.s 8–30 d)
Sert 2023 – CFS (7–9 vs 1–3) (Prolonged ED LOS)
Kayhan Kocak 2023 – CFS (≥5 vs <5) (LOS > 9 days)
Munir Ehrlington 2024 – CFS (≥5 vs <5) (Mort.)
Eckart 2019 – HFRS (30day mort.)
Nygaard 2022 – CFS vs Fried (90day mort.)
Liu 2020 – FSQ (28day mort.)
Elliott 2021 – CFS (2yr mort.)
Chung 2024 – CFS+KTAS (30day inhospital mort.)
Alshibani 2022 – CFS (30day mort.)
Javadzadeh 2023 – CFS (30day mort.)
Nagae 2024 – FILab (Inhospital mort.)
Shiffer 2025 – eFI (EHR) (Inhospital mort.)
Clark 2019 – CFS (28day mort.)
Lewis 2019 – Fried / CFS / SUHB (Comp. "poor outcome")
Ng 2023 – CFS (4–9 vs 1–3) (ICU or inhospital death)
Mowbray 2020 – ED Frailty Index (Hospital admis.)
Serina 2021 – CFS (Indexvisit admis.)
10^0
10^1
Odds / Hazard Ratio (log scale)

Fig. 2 Effect estimates (OR/HR) across studies. Each point represents an odds ratio or hazard ratio for adverse outcomes associated with frailty status. Horizontal lines denote 95% confidence intervals. Colors correspond to outcome categories as in Fig. 1. The vertical dotted line indicates the null value (OR/HR = 1)

suggesting that frailty-based measures provide more relevant insight into patient vulnerability than traditional triage scores alone.

Chung et al., [26]demonstrated that CFS-KTAS, a novel tool that integrates the CFS with the Korean Triage and Acuity Scale (KTAS), enhanced the

prediction of hospital and ICU admissions compared to KTAS alone, reinforcing the value of incorporating frailty into triage systems. Johansson et al., [27],performed a multicenter observational study in Sweden and found that patients with CFS scores between 5 and 8, identifying them as frail, had significantly higher likelihood of being admitted to hospital compared to their non-frail counterparts. A study by Serina et al., [28] performed in an ED in the United States of America, likewise reported that elevated CFS scores were linked to a greater likelihood of hospital admission both during the initial visit and within the following 30 days.

Frailty and ED readmissions

Frailty has been linked to increased risk of ED readmission. Identifying patients at risk for repeat ED visits is essential for preventing avoidable hospitalizations and improving continuity of care.

Zulfiqar et al., [29] evaluated the prognostic ability of the modified Short Emergency Geriatric Assessment (mSEGA) frailty scale in predicting ED readmission and mortality at 12-month in a French ED. The mSEGA tool assesses frailty across 13 domains, including medication use, cognitive function, nutrition, mobility, mood, and living situation. The results showed the mSEGA frailty scale significantly predicted ED readmission within 12 months, although the tool did not predict mortality or other outcomes such as institutionalization. In contrast, the Charlson Comorbidity Index (CCI) was a stronger predictor of 12-month mortality, but it did not predict ED readmission or other outcomes. Notably, there was no clear correlation between high comorbidity scores and frailty levels, highlighting that these tools measure different aspects of patient vulnerability. Mowbray et al., [30] reported that a frailty index tailored for ED (ED frailty index) created by Brousseau et al. [31] predicted future hospitalizations and 30- day ED returns in a study conducted on eight EDs in Canada. Johansson et al., [27] found that patients with severe frailty (CFS scores between 5 and 8) had significantly higher ED revisit rates within 8–30 and 31–90 days post-discharge, often resulting in admission. However, Barton et al., [32] found the CFS had limited predictive utility for ED re-presentations following falls in community-dwelling seniors, suggesting that the effectiveness of frailty tools may vary based on the reason for initial presentation.

Together, these studies suggest that while frailty is a valuable predictor of readmissions, tool selection and context of use are important considerations for maximizing predictive value.

Frailty and length of stay or functional decline

Frailty has been strongly linked to prolonged hospital LOS and declines in functional status, both of which have major implications for older patients' recovery, independence, and quality of life. O'Caoimh et al., [33] validated the Risk Instrument for Screening in the Community (RISC) in detecting adverse outcomes such as hospitalization (LOS and 30-day readmission rates) and one-year rates of institutionalization among older patients attending an ED in Ireland. The RISC uses a five-point Likert scale to estimate one-year risk for hospitalization, institutionalization, and death. The study found the tool effective in predicting hospital LOS and one-year institutionalization rates, highlighting its value for early planning and care coordination. Similarly, Eckart et al., [34] validated the Hospital Frailty Risk Score (HFRS), an ICD-10-based tool, in a Swiss hospital. He demonstrated that the HFRS was associated with longer hospital stays, functional decline, and reduced quality of life.

A prospective study by Liu et al., [35] in China used the Frailty Screening Questionnaire (FSQ) to assess 350 ED patients aged 60 and older. The FSQ showed strong associations with age, malnutrition risk, chronic disease burden, reduced grip strength, and longer hospital stays. Its rapid administration and correlation with both the CFS and objective outcomes suggest its usefulness in fast-paced clinical environments such as the ED. Clark et al., [14] found the CFS was independently linked to longer LOS in socioeconomically disadvantaged patients presenting to an ED in Australia. Munir Ehrlington et al., [18] also found that higher CFS patients were characterized by longer ED and in-hospital LOS compared to non-frail patients. The CFS evaluated by Sert et al., [36] in 920 older adults admitted to ICU via the ED showed that patients with moderate to severe frailty had significantly longer ED stays and higher ICU mortality rates, emphasizing frailty's prognostic value in the

most critically ill. A study by Kayhan Kocak et al. [37] compared CFS, Identification of Seniors At Risk (ISAR), and Triage Risk-Screening Tool (TRST) for predicting hospital LOS and functional dependency in older patients transferred from the ED to internal medicine wards. While all tools predicted functional disability, only the CFS and TRST were associated with longer hospital stays, though logistic regression showed no significant independent associations. Among the tools, the CFS emerged as the most reliable predictor of disability, although limited in predicting actual disability.

These findings collectively reinforce the value of frailty screening in anticipating longer admissions and guiding early intervention to prevent and manage decline.

Interestingly, although single-parameter biomarkers such as gait speed and grip strength are recognized as objective measures of frailty and strongly correlate with adverse outcomes in community and inpatient cohorts [38, 39], none of the ED-based studies identified in this review employed these metrics, reflecting feasibility and safety constraints in acute emergency settings.

Comparative effectiveness of frailty tools

Although many frailty tools have been developed, none has emerged as the universal standard for ED use. Each tool captures different aspects of frailty such as physical, cognitive, functional, or comorbid, and their relative strengths vary depending on clinical context, setting, and desired outcomes. Studies comparing these tools provide insights into their relative strengths, predictive accuracy and practical utility in the ED setting.

Comparative studies show that while the CFS remains the most validated and feasible tool for ED use, other instruments capture complementary aspects of vulnerability. In Danish and Australian cohorts, both the CFS and FP were associated with 90-day mortality, but the CFS demonstrated superior predictive accuracy and practicality for rapid ED assessment [9, 20] The SUHB and FP performed similarly for adverse outcomes but were less applicable due to their physical-performance requirements [9]. In a large UK cohort, the HFRS, derived from administrative data, showed comparable discrimination for 30-day mortality and prolonged length of stay but only weak correlation with CFS scores, indicating that these measures reflect distinct but complementary frailty dimensions [40]. Collectively, these studies support the CFS as the most pragmatic single-tool option, while automated indices such as HFRS or hybrid and lab-based models, such as FI-Lab, TFC, provide scalable alternatives where digital data systems are established.

The following section summarizes comparative findings across frailty instruments and their relative performance in the ED setting.

FI-lab vs. NEWS vs. JTAS

As mentioned before, automated frailty scores based on lab values are gaining traction. Nagae et al. [24], compared the FI-lab with standard prognostic tools such as NEWS and the JTAS in a retrospective study analyzing 872 older ED patients. The FI-Lab performed comparably to NEWS and JTAS in predicting in-hospital mortality and prolonged LOS. However, none of the tools effectively predicted in-hospital falls, highlighting the limitations of physiological tools in capturing mobility-related risks.

TFC tool vs. CFS, PRISMA-7, and ISAR

Zaboli et al. [41, 42] compared the Triage Frailty and Comorbidity (TFC) tool, a recently validated tool [42], to other frailty scales in an ED. While the CFS, PRISMA-7, and ISAR were used for patients over 65 years old, the TFC was applied to all age groups. The TFC tool significantly outperformed the CFS, PRISMA-7, and ISAR in predicting 30-and 90-day mortality, hospitalization across all age groups. Notably, the TFC tool effectively assesses frailty in the entire adult population, making it especially suitable for broad application in emergency settings.

APOP, InterRAI ED, ISAR-HP, and VMS

A large Dutch cohort study by Van Dam et al., [43] evaluated the prognostic accuracy of four frailty screening tools, the Acutely Presenting Older Patient (APOP1), InterRAI ED, ISAR-Hospitalized patients (ISAR-HP), and VMS, for predicting adverse outcomes among older ED patients [43]. The tools showed poor to moderate predictive performance accuracy, with the APOP1 and ISAR-HP performing

slightly better than the others. The findings call into question the practical utility of these tools for identifying high-risk older adults in emergency care.

ISAR-HP vs clinical judgment vs patient-perceived frailty

In a follow up study, Van Dam et al., [4] compared clinical judgment, patient-perceived frailty, and the validated ISAR-HP tool in assessing frailty. The study found only fair agreement between these methods. Despite reasonable sensitivity for identifying adverse outcomes (functional decline, institutionalization, or mortality), each method demonstrated poor prognostic accuracy, suggesting limited clinical utility even when combined. These findings highlight the limitations of relying solely on clinical judgment or self-assessment for frailty screening in emergency settings.

ISAR, fTRST, and interRAI ED

A prospective study by Heeren et al., [44], conducted in a Belgian ED, assessed the diagnostic accuracy of the Flemish version of the TRST (fTRST), ISAR, and the interRAI ED Screener for their ability to predict prolonged ED LOS, hospitalization following the index ED visit, and unplanned ED readmission at 30 and 90 days. All 3 tools demonstrated similar diagnostic performance, with moderate to high sensitivity but very low specificity and poor overall accuracy in predicting adverse outcomes among older ED patients. None of the tools effectively altered post-test probabilities, suggesting limited utility as stand-alone predictors.

Taken together, these comparisons reinforce that no single tool captures all dimensions of frailty with high precision.

Triage acuity vs. frailty assessment

Conventional triage systems such as the Canadian Triage and Acuity Scale (CTAS), the KTAS, and the Taiwan Triage and Acuity Scale (TTAS) are widely used to prioritize patients in EDs based on physiological severity. However, mounting evidence suggests that these systems may not adequately capture frailty-related risks, particularly in older adults, potentially leading to under-triage and missed opportunities for early intervention.

Mowbray et al., [30] conducted a secondary analysis across 8 Canadian EDs to explore the relationship between triage acuity and frailty as well as their associations with various patient outcomes. Using the CTAS and a ED frailty index for frailty measurement [31], they found no correlation between the traditional triage scores and frailty levels. However, the ED frailty indices correlated with increased hospital admissions, longer LOS, and repeat visits, underscoring the limitations of physiologic triage alone in the geriatric population. Several other studies have explored the integration of frailty in triage systems. Chung et al., [26] integrated the CFS with the KTAS, termed CFS-KTAS, to evaluate its effectiveness in improving triage outcomes for older patients in EDs across three centers in Korea. The study showed that the hybrid model CFS-KTAS significantly improved the prediction of admissions and 30-day mortality over the KTAS alone. This suggests that incorporating frailty assessment into triage decisions can substantially enhance prognostic accuracy for hospital outcomes in older ED patients. Another similar approach was taken by Ng et al., [45] in Taiwan. Their team integrated the CFS with the TTAS into a new combined tool, the Triage Frailty Acuity Scale (TFAS), for older ED patients. TFAS showed superior predictive accuracy for ICU admission and in-hospital mortality compared to TTAS alone. Although TFAS did not increase resource use such as ED medical expenditures or number of tests, it led to longer hospital stays. Importantly, the TFAS identified many patients who were initially triaged as less urgent but subsequently experienced critical events, suggesting that incorporating frailty assessments into ED triage can reduce under-triage among elderly patients. In Thailand, Supatanakij et al., [46] developed S-TRIAGE, a geriatric-specific triage risk score incorporating respiratory rate, oxygenation, shock index, systolic blood pressure, temperature, and altered mental status. This single center study involving older adults presenting to the ED, showed that the S-TRIAGE achieved an AUC of 0.826 in predicting 28-day mortality and could be useful in early identification of critically ill older adults needing life-saving interventions.

Collectively, these findings make a compelling case for frailty-informed triage systems. Traditional

acuity scales, while valuable for assessing acute physiological instability, often miss the nuanced vulnerabilities of older adults. Frailty-integrated triage models, such as CFS-KTAS, TFAS, and S-TRIAGE, represent promising advancements that can enhance risk stratification, reduce under-triage, and support more individualized emergency care for the aging population.

Electronic and automated frailty screening

As EDs increasingly adopt electronic health records, automated frailty assessment could become a practical and scalable solution for identifying high-risk older adults. Automated frailty indices use routinely collected clinical data, such as diagnoses, prescriptions, lab values, and functional assessments, to estimate frailty without requiring additional time or resources from clinicians. One of the earliest examples of this approach is the Frailty Index for Emergency Departments (FI-ED) [31] using the interRAI ED-Contact Assessment. This tool showed strong associations with adverse outcomes such as hospital admission, 28-day mortality, and discharge to long-term care. Similarly, Shiffer et al. [6] developed a novel eFI based on 45 variables to predict hospitalization, in-hospital mortality, ICU admission, and 30-day ED readmission among 21,537 older ED patients. The results showed that increasing frailty was significantly associated with worse outcomes. As noted earlier, Nagae et al., [24] similarly validated the FI-lab as a biomarker-based frailty index using routine lab parameters. It predicted mortality, prolonged LOS, and discharge but not in-hospital falls, highlighting its disease severity focus.

These electronic and lab-based tools offer several advantages. They are objective, reproducible, and compatible with real-time clinical workflows. Moreover, they minimize inter-rater variability and facilitate rapid decision-making. However, their effectiveness depends on the quality of underlying data and the existence of well-integrated health information technology. In settings where such systems already exist, electronic frailty indices models may significantly transform frailty screening from a subjective task into a standardized, automated process.

Beyond rule-based algorithms, emerging artificial-intelligence and machine-learning models can derive frailty risk directly from electronic health record data, imaging, or clinical-note text. These methods may enable continuous recalibration of risk thresholds and fully automated frailty detection.

Discussion

This review highlights the role of frailty assessment in ED for older adults. The CASP-based appraisal demonstrated that the overall methodological quality of the 32 included studies was generally high to moderate, reflecting solid research design and consistent use of validated frailty measures. Prospective multicentre cohorts, especially those evaluating the CFS, FaP-ED, and TFAS tools, scored highest for measurement validity and outcome ascertainment. Retrospective registry analyses such as HFRS, eFI, FI-Lab were limited mainly by residual confounding data. The most common sources of moderate bias were related to attrition and lack of standardized assessor training. In total, 21 studies were rated high quality and 11 moderate quality. These results indicate that the current evidence base for frailty assessment in the ED is methodologically robust but would benefit from harmonized reporting standards and expanded external validation across different healthcare systems.

To aid clinical translation, Table 2 outlines the principal advantages, limitations, and suggested emergency-department applications of the main frailty tools evaluated.

In addition, Supplementary Table S2 summarizes the principal determinants and data sources underlying each major frailty tool, highlighting variability in the domains assessed ranging from clinical judgment to biomarker based indices.

The literature supports frailty as an independent and consistent predictor of adverse outcomes, including short- and long-term mortality, prolonged hospital stays, functional decline, ICU admission, and ED-readmissions. Frailty, unlike age or comorbidity alone, consistently serves as a powerful, independent predictor of poor prognosis in older adults presenting to the ED.

Among the various screening tools, the CFS stands out for its widespread use, ease of application, and strong predictive performance [13, 16–18]. However, its reliance on clinical judgments makes it vulnerable to inconsistencies, particularly in busy ED

environments [21]. While CFS is widely used, alternatives like PRISMA-7, mSEGA, and RISC have also demonstrated value in specific contexts, especially for predicting mortality, ED readmissions or functional decline [25, 29, 33]. Yet, none of these tools capture the full complexity of frailty on their own.

Comparative studies reveal that different frailty instruments offer varying degrees of sensitivity, specificity, and feasibility. For example, CFS outperforms FP [9], while tools like the TFC and FI-Lab integrate broader clinical or laboratory data for enhanced objectivity [24, 41]. Importantly, these newer models show that hybrid or automated tools can match or exceed traditional frailty assessments in accuracy while reducing clinician workload.

A particularly promising development is the integration of frailty into triage systems, such as CFS-KTAS, TFAS, and S-TRIAGE [26, 45, 46]. These hybrid tools combine vital parameters with frailty markers to improve risk stratification without increasing clinical burden. Evidence suggests they reduce under-triage, better identify vulnerable patients, and do so without escalating resource use.

Meanwhile, electronic frailty indices and lab-based tools like the eFI and FI-Lab represent the next frontier. Their automation, scalability, and ability to operate in real time position them as ideal candidates for future ED integration, particularly in health systems with robust digital infrastructure. These tools may eventually support real-time, automated risk stratification, offering a more consistent and data-driven foundation for shared decision-making. However, their implementation depends on robust electronic health record systems and institutional capacity for automation.

Observed performance of frailty tools varied widely across studies, and it is plausible that this variation is shaped by health-system context, including triage models, data infrastructure, staffing and training, case mix, and post-acute pathways. For example, integrating the CFS into Taiwan's national triage markedly improved discrimination for critical events such as ICU admission and in-hospital death, an effect that may not translate where triage workflows or escalation thresholds differ [44]. In Switzerland, CFS showed high discrimination for 30-day mortality when structured assessor training was implemented, highlighting the influence of implementation capacity [13]. By contrast, the Dutch and Belgian multicentre studies reported only poor-to-moderate prognostic accuracy for commonly used screeners such as APOP, ISAR-HP, and interRAI ED [42, 43], consistent with differences in ED staffing, measurement windows, and outcome capture.

Data infrastructure also affects performance. The HFRS depends on ICD-10 coding and prior admissions. In a Swiss validation, discrimination for 30-day mortality was moderate [34], while a UK ED cohort found only slight agreement between HFRS and incident CFS scores at triage [39], underscoring that automated indices are sensitive to local coding practices. Outcome definitions and service organization likewise differ. A large U.S. cohort found CFS predicted admission with modest discrimination [28], whereas a Dutch ED study of the VMS program showed limited positive predictive value but high negative predictive value for 90-day mortality and falls [23]. Both are likely influenced by local admission thresholds, revisit policies, and community care capacity. In contrast, an Australian multicentre study reported stronger performance for FP, CFS, and SUHB against a composite poor outcome, reflecting outcome construction and discharge-planning norms [9].

Cultural and linguistic factors further limit generalizability for self-report instruments such as ISAR, FSQ, and mSEGA. In France, mSEGA identified marked 12-month mortality and readmission-free survival gradients [29], while in China, the FSQ predicted 28-day mortality [35]; transferability of such tools may depend on cognitive screening at triage, proxy availability, and language adaptation. Hybrid tools combining frailty and vital-sign aggregation, such as the FaP-ED model built on the NEWS, achieved higher AUCs in systems where NEWS is standardized. Where early-warning systems are absent, performance may be lower [22]. Socio-economic context also shapes baseline risk and utilization. In an Australian community hospital serving a socio-economically disadvantaged area, increasing CFS scores were associated with higher mortality, admissions, and repeat ED presentations [14], though operational impact will vary with local resource constraints.

Collectively, these findings underscore that frailty-tool performance is context-dependent. Local validation, recalibration of cut-points, alignment with existing triage and early-warning systems, explicit

Table 2 Practical advantages, limitations, and suggested clinical applications of frailty assessment tools in the ED

Frailty tool	Strengths/advantages	Limitations/considerations	Suggested clinical use
CFS	Rapid (< 1 min) bedside tool; visually intuitive; widely validated; strong predictor of mortality and admission	Subjective; requires training; moderate inter-rater variability under high workload	Bedside frailty screening; can be integrated into triage with standardized assessor training
ISAR	Very brief self-report; easily administered by nursing staff; good sensitivity	Low specificity; dependent on patient cognition and language; limited calibration	Quick pre-triage screen or as part of registration/initial nurse assessment
TRST/fTRST	Nurse-administered; moderate sensitivity for admission risk	Limited predictive accuracy; excludes non-communicative or delirious patients	Use in geriatric-focused EDs or observation units alongside clinical assessment
PRISMA-7	Short (7 items); validated for mortality and ICU admission; feasible for non-clinical staff	Requires patient cooperation and translation; lacks physical performance domains	Rapid screening during triage or registration, when self-report feasible
RISC	Multidimensional; predicts institutionalization and long-term outcomes	Time-consuming; complex scoring; limited applicability in acute settings	Discharge planning, follow-up programs, or geriatric assessment clinics
HFRS	Automated from ICD-10 data; scalable and reproducible; no staff time required	Dependent on coding accuracy and previous admissions; poor sensitivity for first presentations	Retrospective audits; real-time risk flag in EHR-integrated systems
Electronic or Lab-Based Indices (eFI/FI-Lab)	Objective, reproducible, and compatible with electronic records; minimizes observer bias	Requires digital infrastructure; not yet available in real time in most EDs	Automated background frailty flag in digital hospitals or integrated EHR systems
FaP-ED (CFS + NEWS)	Combines frailty and physiological risk; superior mortality prediction over CFS or NEWS alone	Requires standardized NEWS implementation; moderate complexity	Systems routinely using NEWS; hybrid triage and risk stratification
TFAS/CFS-KTAS/S-TRIAGE	Incorporate frailty into triage; improve mortality and ICU prediction; reduce under-triage	Requires adaptation to local triage protocols and staff training	High-volume EDs with structured triage systems
mSEGA//FSQ	Multidimensional, incorporating functional and psychosocial domains; correlates with functional decline	Time-consuming; requires cultural and linguistic adaptation	Observation units or EDs with extended assessment capability

reporting of calibration (not only AUC), coder training for claims-based tools, and cultural or linguistic adaptation for self-report instruments are essential. Embedding assessor training and reliability checks, and integrating frailty assessment within routine triage workflows, appear to enhance transportability and real-world yield.

Nevertheless, many tools still struggle to accurately predict outcomes [4, 43, 44]. Emerging evidence highlights the biological and pharmacologic determinants of frailty that may complement functional assessment in the ED. Frailty-related vulnerability has been linked to nutritional status, chronic inflammation, and oxidative stress. In hospitalized older adults, routinely available biochemical, hematological, and immunological blood parameters such as albumin, hemoglobin, total protein, homocysteine, C-reactive protein, and interleukin-6, vary systematically according to validated nutritional risk instruments (Mini Nutritional Assessment and Geriatric Nutritional Risk Index), identifying malnutrition and overlapping vulnerability states closely aligned with frailty [47]. Another more recente study further demonstrate associations between nutritional risk and adipokine and oxidative stress markers, including leptin, resistin, oxidized low-density lipoprotein, and glutathione peroxidase activity, reflecting disrupted redox balance in malnourished older adults [48]. Although not all of these biomarkers are routinely obtained during acute care, those that are already available as part of standard laboratory evaluation can provide complementary biological context. When incorporated into automated or electronic frailty indices, such data may enhance biological characterization without adding time or assessment burden for clinicians.

Indeed, additonal studies support the relevance of routinely collected biological data in frailty identification. A recent study from Beijing identified inflammatory biomarkers, including the neutrophil-to-lymphocyte ratio, high-sensitivity C-reactive protein, fibrinogen-to-albumin ratio, and erythrocyte sedimentation rate, to be strong independent predictors of frailty [49]. A Swiss study demonstrated that polypharmacy modifies frailty-related mobility. They found that concomitant ACE inhibitor or aspirin use reversed the negative association between statin therapy and gait speed reserve[50]. These findings suggest that routinely collected laboratory and medication data could enhance real-time frailty detection and risk stratification in the ED, supporting integration of biomarker-informed and pharmacology-aware models into future multidomain screening frameworks.

While predictive accuracy is important, future research must also focus on clinical impact to determine how the implementation of these tools in the ED could change care, reduce harm, or improve patient-centered outcomes.

Conclusion

Frailty assessment in the ED is essential. As older adults represent a growing proportion of ED users, timely identification of frailty can inform more personalized, proactive care strategies. This review underscores the predictive ability of both clinical and automated frailty tools. While further standardization and validation across diverse settings are needed, the integration of frailty screening into ED workflows, ideally through scalable, automated systems, offers a path toward more targeted interventions, improved resource allocation, and better outcomes for vulnerable patients. Ultimately, the future of emergency care for older adults may depend not just on how sick a patient is, but on how frail they are, and how early it is detect.

Author contribution All authors contributed to this review's conception and design. Data collection, extraction, and analysis were performed by Dana Shiffer, Francesco Reggiani, and Antonio Voza. The first draft of the manuscript was written by Dana Shiffer and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Funding None declared.

Declarations

Ethics approval and consent to participate Not applicable.

Conflict of interest The authors declare no competing interests.

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